

brachytherapy of the prostate, compared to a SSCP. The primary objective of this study was to investigate whether a DSCP leads to more similarity between an online plan based on TRUS and a post plan based on CT, compared with SSCP. The secondary objective was to determine whether the post-plan based DVH parameters improved using with the DSCP technique compared with the SSCP technique.

Materials and Methods: In the study 50 consecutive patients with prostate cancer were included, who were treated between March 2008 and March 2010. The first 25 of these patients had their online planning based on a SSCP, the plans of the other 25 patients were based on a DSCP TRUS. Three weeks after implantation a post planning was made based on CT. TRUS online and CT post plan dose volume histogram (DVH) parameters, D90 and V100, were compared for both groups. Also, the post plan DVH parameters of SSCP were compared with DSCP. The possible factors that might influence the post plan D90 and V100 were analysed using ANOVA.

Results:

Table:	Value, SSCP group	Value, DSCP group	Value, large prostate group	Value, intermediate prostate group	Value small prostate group
o plan	170.12 Gy (SD 14.19)	167.94 Gy (SD 11.13)			
plan (CT)	149.53 Gy (SD 20.03)	147.64 Gy (SD 23.33)	141.1 Gy	145.3 Gy	159.0 Gy
e plan	99.1% (Range 91.5 – 99.1%)	99.3% (Range 97.7 – 99.9%)			
plan (CT)	93.1% (Range 64.7 – 98.4%)	90.1% (Range 56.8 – 99.6%)	87.0%	89.6%	93.8%

The SSCP and DSCP online mean D90 and V100 were significantly larger than post plan mean D90 and V100 ($P < 0.01$). The post plan mean D90 and mean V100 were both non-significantly larger for the with SSCP implanted patients, compared to the with DSCP implanted patients ($P = 0.76$ and $P = 0.68$). The online-plan D90 and V100 in the DSCP group were very similar among the patients, compared to the SSCP group. The SD's of the D90 of SSCP and DSCP were 14.2 Gy and 11.1 Gy and the V100 ranged from 91.5 to 99.1% and from 97.7 to 99.9%, respectively. ANOVA showed significant impact of prostate volume on the post-plan D90 ($P < 0.01$) and V100 ($P = 0.02$).

Conclusions: The longer sagittal view of the prostate and surrounding tissues with the DSCP enabled better visualisation in one view, which resulted in more homogeneous online plans among patients. However, the DVH parameters showed that this did not lead to more accurate online planning. The TRUS and CT based D90 and V100 showed statistical significant difference, whereas the post plan based D90 and V100 did not improve with the DSCP technique compared to the SSCP technique. Both types of probes are equally accurate for permanent prostate brachytherapy treatment planning. The most important factor found to influence DVH parameters was the prostate volume.

PO-0972

Interobserver variability of 3T and 1.5T MRI/CT fusion-based postimplant dosimetry of prostate brachytherapy

N. Katayama¹, M. Yamashita², K. Bekku³, R. Tanimoto³, E. Suzuki⁴, M. Takemoto⁵, K. Katsui¹, Y. Nasu³, H. Kumon³, S. Kanazawa¹

¹Okayama University Hospital, Radiology, Okayama, Japan

²Okayama Rosai Hospital, Radiology, Okayama, Japan

³Okayama University Hospital, Urology, Okayama, Japan

⁴Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama, Japan

⁵Japanese Red Cross Society Himeji Hospital, Radiology, Himeji, Japan

Purpose/Objective: In 3-Tesla MRI image, the seeds and the contours of prostate and urethra are clearer than in 1.5-Tesla MRI image. Meanwhile, their reliability has been less investigated, and it remains unclear which procedure is more reliable. We assessed the interobserver variability in 3-Tesla and 1.5-Tesla MRI/CT fusion-based postimplant dosimetry of prostate brachytherapy.

Materials and Methods: Between July 2009 and December 2010, a total of 26 consecutive prostate cancer patients underwent brachytherapy and 1.5-Tesla MRI and CT (1.5T) were performed on day 30. Subsequently, between December 2010 and November 2011, another 26 consecutive prostate cancer patients underwent brachytherapy and 3-Tesla MRI and CT (3T) were performed on day 30. All the patients were treated with 144 Gy of brachytherapy alone. Two radiation oncologists performed MRI/CT fusion-based postimplant dosimetry. The interobserver variability of dose-volume histogram (DVH) parameters (prostate D90, prostate V100, prostate V150, urethral D5, and urethral V200) was calculated by using Pearson's correlation coefficients. Differences in means of DVH parameters were also tested by using a paired t test.

Results: Pearson's correlation coefficients of 3T were larger than those of 1.5T in all the DVH parameters (prostate D90, 1.5T: 0.66, 3T: 0.85; prostate V100, 1.5T: 0.63, 3T: 0.68; prostate V150, 1.5T: 0.96, 3T: 0.98; urethral D5, 1.5T: 0.84, 3T: 0.92; urethral V200, 1.5T: 0.77, 3T: 0.92). In a paired t test, none of the DVH parameters were statistically significant in 3T ($0.082 \leq p \leq 0.26$). In 1.5T, however, significant differences were observed in prostate D90, prostate V100, and prostate V150 ($p < 0.001$).

Conclusions: The interobserver variability of 3-Tesla MRI/CT fusion-based postimplant dosimetry was smaller than that of 1.5-Tesla MRI/CT fusion-based postimplant dosimetry, suggesting that the former is more reliable among prostate cancer patients undergoing brachytherapy.

PO-0973

Electromagnetic tracking accuracy of the AURORA planar field generator for prostate brachytherapy protocol

S. Boutaleb¹, O. Fillion¹, D. Binnekamp², L. Beaulieu¹

¹Centre de Recherche en Cancerologie de l'Université Laval, Radio-oncology, Quebec, Canada

²Clinical Innovations, Philips Electronics Nederland B.V., Eindhoven, The Netherlands

Purpose/Objective: The electromagnetic tracking systems (EMTS), initially employed in virtual reality experiments, are more and more integrated in several medical protocols. That technology can improve the accuracy of physician's gestures from real time tracking of positions and orientations of needles or catheters. However, the electromagnetic field distortion, due to metallic structures or medical devices in the environment, is not negligible and has to be characterized. For prostate brachytherapy, there are several metallic elements and electronic tools close to the zone of detection: the operating table, the needles, the template, the ultra-sound probe stabilizer and an important concentration of small seeds in volume of interest during low-dose rate (LDR) brachytherapy. The purpose of this study is to characterize the performance of the planar field generator Aurora (Northern Digital Inc., Waterloo, Canada) as a real-time, high accuracy needle guidance technology in prostate brachytherapy.

Materials and Methods: All measurements have been recorded in an environment free of electromagnetic disturbances. The characterization of the planar field generator Aurora from NDI included the definition of volume boundaries, the errors calculations of position and orientation for the sensor throughout this volume. For these measurements the sensor (5 degrees of freedom (5DOF)) was integrated into a needle from a biopsy introducer set (PHILIPS developed EM system). The needle support could be moved accurately with a sub-millimeters displacement (± 0.25 mm) everywhere in the measurement volume ($600 \times 600 \times 600$ mm³) in front of the generator. To estimate the accuracy of position, 486 measurements were recorded into the volume of interest. In addition, 22 measurement points, covering from X to Y degrees, were utilized to evaluate the accuracy of orientation measurements. The latter were repeated for needle orientations parallel ($\pm 90^\circ$) and perpendicular (0°) to the central axis of the field generator.

Results: Results show that the standard deviation on sensor position is less than 0.04 mm when needle is located within 26 cm of generator, but start increases significantly beyond 35 cm. When needle is on volume edges (at 60 cm) the position defined by EMTS is underestimated by 16.0 ± 0.6 mm. The errors on the measured orientation were low at $\pm 1^\circ$, except when the needle is perpendicular to the generator, at more than $375 (\pm 1)$ mm; the error on the orientation rises exponentially with distance up to 4.5° at $575 (\pm 1)$ mm.

Conclusions: Our work shows that the EMTS Aurora planar field generator seems to possess the needed accuracy to enable real-time needle/catheter guidance for brachytherapy applications. As recommended practices, the needle should be parallel with the generator plan, and the treatment zone should be ideally kept within

the first half of 3D detection volume, no farther than 30-35 cm away from the generator.

PO-0974

Organ doses in a male phantom undergoing high-dose-rate brachytherapy applied to localized prostate carcinoma

C. Candela-Juan¹, F. Ballester², J. Perez-Calatayud³, M.J. Rivard⁴

¹La Fe University and Polytechnic Hospital, Radioprotection Department, Valencia, Spain

²University of Valencia, Department of Atomic Molecular and Nuclear Physics, Burjassot, Spain

³La Fe University and Polytechnic Hospital, Radiotherapy Department, Valencia, Spain

⁴Tufts University School of Medicine, Department of Radiation Oncology, Boston, USA

Purpose/Objective: The aim of this study was to obtain equivalent doses to radiosensitive organs when applying high-dose-rate (HDR) brachytherapy to a localized prostate carcinoma using ⁶⁰Co or ¹⁹²Ir sources, and in comparison to external-beam radiotherapy (EBRT).

Materials and Methods: Monte Carlo (MC) simulations in Geant4 were performed using a voxelized phantom described in International Commission on Radiological Protection (ICRP) Publication 110, which reproduces masses and shapes from an adult reference man defined in ICRP Publication 89. Point sources of ⁶⁰Co or ¹⁹²Ir with photon energy spectra corresponding to those exiting their capsules were placed in the center of the prostate. Equivalent doses per clinical absorbed dose to the prostate were obtained in several radiosensitive organs. Values were corrected to account for realistic source dwell times and positions throughout the prostate. This was repeated for a homogeneous water phantom to assess the adequacy of a homogeneous phantom for HDR dose calculations. Brachytherapy doses were compared to reported values from three-dimensional conformal radiotherapy (3D-CRT), intensity-modulated radiation therapy (IMRT), and proton therapy.

Results: For the nearest organs considered (bladder, rectum, testes, small intestine, and colon), equivalent doses given by ⁶⁰Co source were smaller than from ¹⁹²Ir. As the distance increased, the more penetrating gamma-rays produced by ⁶⁰Co delivered higher equivalent doses. Relative to ¹⁹²Ir, the dose ratio increased up to a factor 5 for the brain. Due to the photoelectric effect and the passage of photons through different tissues (bone, air, and lungs), differences between the heterogeneous and the water phantom became apparent at distances larger than 30 cm. Finally, for the closest organs, equivalent doses from the three EBRT modalities were within an order of magnitude to equivalent doses deposited by both brachytherapy sources. However equivalent doses from brachytherapy were up to two orders of magnitude smaller than EBRT for the furthest organs.

Conclusions: According to physical considerations, ⁶⁰Co appears dosimetrically advantageous over ¹⁹²Ir sources at close distances, but not for the furthest organs. On the other hand, equivalent doses to distant healthy organs were lower for brachytherapy than the three studied EBRT modalities.

PO-0975

Early tolerance and feasibility of salvage prostate HDR brachytherapy combined with interstitial hyperthermia

A. Kukiela¹, M. Hetnał¹, T. Dabrowski¹, T. Walasek¹, P. Brandys²

¹Centre of Oncology - Institute MSC Kraków, Department of Brachytherapy, Krakow, Poland

²Centre of Oncology - Institute MSC Kraków, Department of Radiotherapy, Krakow, Poland

Purpose/Objective: Evaluation of feasibility and early tolerance of interstitial hyperthermia combined with salvage prostate brachytherapy in patients with BGI confirmed local recurrence after previous external beam radiotherapy.

Materials and Methods: Between 16th December 2008 and 25th October 2012, in the Centre of Oncology in Cracow, 21 patients with biopsy confirmed local recurrence of previously irradiated prostate cancer were qualified for salvage HDR brachytherapy of the prostate combined with interstitial hyperthermia using BSD500 equipment (BSD Medical). 55 hyperthermia procedures had been performed out of planned 63 (87,3%). The reason for quitting procedure was failure of the hyperthermia equipment in 5 cases and only saddle block anaesthesia in 3 patients cases. The aim of the hyperthermia treatment was to heat (in asynchronous mode in order to protect the urethra) the peripheral zone of the prostate to 41 - 43°C for 60 minutes. All patients were treated with the brachytherapy dose of 30 Gy in 3 fractions, 10 Gy each, with 3-week intervals between fractions. 3D inverse planning under TRUS control was performed using SWIFT or ONCENTRA Prostate ® systems, Nucletron™.

Results: Combined treatment including interstitial hyperthermia and

HDR brachytherapy is feasible during the period of standard subarachnoid anaesthesia for brachytherapy. Mean therapeutic hyperthermia duration was 50 minutes (range 30 - 60). Mean temperature in the prostate during the procedure was 41,2°C (range 38,4 - 42,9°C), maximal temperature measured in the prostate was 41,9°C (range 40,4 - 43,4°C), and mean temperature in the rectum was 38,5°C (range 37,1 - 42°C) - 20 measurements in rectum were done. The most frequent complications in the first 3 months after treatment were: nocturia 3x - 28,5%, 4x and more - 38%, weak urine stream, G1 - 52%, G2 - 24%, urinary frequency G1 - 38%, G2 - 24%, hematuria G1 - 47,5%, G2 - 9,5%, non-bacterial inflammation of the urethral or bladder G1 - 38%, urgency G1-38%, G2 - 5%; perineal, penile or abdominal pain G1 - 19% (self limiting usually in 24-48 hours), residual urine G1 - 19%, G2 - 14%, urinary incontinence G1 - 14%. In 1 patient rectal complications were observed (G2 - hemorrhage). We didn't observe early complications in the degree G3 and G4.

Conclusions: Early tolerance of interstitial hyperthermia in combination with HDR brachytherapy is good. No early grade 3 or 4 complications were found in the analysed group of patients. The most common mild complications were urination frequency, nocturia, hematuria and transient weakening of urine stream.

PO-0976

Hypofractionated EBRT + HDR Brachy Boost: Lowers prostate cancer treatment burden without increasing side effects

A.G. Martin¹, W. Foster¹, E. Vigneault¹, N. Vrafalvy¹, S. Aubin¹, L. Beaulieu¹, P. Despres¹

¹Centre Hospitalier Universitaire de Québec L'Hôtel-Dieu de Québec, Radiation Oncology, Quebec, Canada

Purpose/Objective: The purpose of this study is to demonstrate the feasibility and safety of combining a brachytherapy boost with an hypofractionated EBRT regimen in prostate cancer treatment and compare it to our current standard approach, toxicity wise.

Materials and Methods: 1050 patients have been treated with brachytherapy boost (HDRBB) in our facility, all of which we prospectively cumulated treatment data. At follow-ups, patients filled in forms reporting side effects and IPSS scoring. 157 intermediate risk patients were treated with our standard fractionation scheme (Std) (40-44Gy in 20-22 fractions) plus HDRBB (15Gy single fraction). An experimental group of 30 patients (Table 1) were treated with (Hypo) (36Gy in 12 fractions) and HDRBB. Both groups share similar pre implants characteristics.

Results: Median IPSS scores at consultation and at 1, 3, 6, 12 months after treatments are reported in Table 2 as compared with the FU reports of our experimental group. No GI grade 3 or 4 toxicities were reported in the later group. Patients benefited of a reduction in treatment course up to 13 days of treatments.

		Hypo (n = 30)	Std (n = 157)
Age (years)	Median (Std dev)	66 (±7,27)	65 (±6,46)
Initial PSA	Median (Std dev)	3,7(±3,17)	5,9 (±3,54)
	≤ 10	28 (93%)	121 (77%)
	> 10 <20	2 (6%)	36 (23%)
Clinical stage	T1C	21 (70%)	97 (61%)
	T2A	7 (23%)	36 (23%)
	T2B	2 (7%)	24 (15%)
Gleason score		7	7
Risk group		Int	Int
Hormonal therapy		8 (26,7%)	18 (11,5%)

Table 1 : Population demographics.

Treatment \ Median IPSS score	pre (Std Dev)	1 month (Std Dev)	3 months (Std Dev)	6 months (Std Dev)	12 months (Std Dev)
Hypo (n= 30)	4 (± 7,07)	10,5 (±8,12)	5 (±8,13)	6 (±5,18)	8 (±7,37)
Std (n=157)	6 (±6,67)	10 (±7,96)	7 (±9,97)	8 (±8,48)	9 (±7,22)

Table 2 Median IPSS score evolution prior and post treatment.

Conclusions: Hypofractionated Radiation course plus brachytherapy boost for prostate cancer seems to benefit our patients in reducing the total length of their treatment from 23 days to 13 days. More importantly, this new regiment did not increase the GU nor GI toxicity.